JEWELL

On the Structure and Relationship of a New Amphibian Cestode

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MINNA ERNESTINE JEWELL
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I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY Minna Ernestine Jewell

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Henry B. Ward
In Charge of Thesis

Henry B. Ward
Head of Department

Recommendation concurred in:*

	Committee
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	Final Examination*

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INTRODUCTION

In the fall of 1914, while looking over a number of frogs for parasites, I found a cestode in the intestine of a cricket frog, Acris gryllis. Further collections were made and the repeated occurrence of the tape worm showed that it was not merely incidental but was a regular parasite of the host mentioned. This discovery was particularly interesting because of the rarity of Cestodes, either species or individuals, in the Amphibians. So far as I have been able to ascertain only four Cestodes have as yet been described from Amphibians and of these only one, Taenia dispar Goeze (1782) is from Anurans. No Cestodes have ever been described from a member of the genus Acris. For these reasons it was considered worth while to make a morphological and systematic study of this new form, the results of which are presented in the following paper.

To Professor Henry Baldwin Ward my sincere thanks are due both for many valuable suggestions and criticisms and for the encouragement and inspiration which have made the work enjoyable.

MATERIALS

Collection. The materials to be discussed in this paper were obtained from cricket frogs, Acris gryllis var. creptans, collected from a drainage ditch about one-half mile north of the center of Urbana. Most of the collecting was done in the rather restricted area between the Market Street bridge and the second bridge northeast of it. Of the 63 cricket frogs examined from this region 22, or about 35 o/o, were infected. Ten cricket frogs taken from the same ditch about a mile north, or up stream, from the territory noted, eleven taken from the Vermillion river near Homer Park, and three from the Sangamon river near Mahomet showed no infection.

Collections were made from the first territory mentioned on October 11 and 23, November 5 and 28, February 15, and March 16. From each collection both young and adult worms were obtained. The heaviest infection found consisted of two worms in which the oldest proglottids were not yet mature, and five mature worms the longest of which, when moderately extended, measured 40 mm.

Position in Host. These tape worms are found in the intestine of the host, usually near the anterior end, though a few have been found attached about midway between the stomach and the cloaca. In numerous instances the scolex and as much as 1 mm. of the neck have been observed to be buried in the intestinal wall of the host. In one instance a mature worm was found in the body cavity of the host having evidently penetrated the intestinal

wall. The presence of long strings of ripe proglottids in the body cavity suggested that the worm had occupied this position for some time.

TECHNIQUE

The specimens were killed in corrosive acetic or 2 o/o formol. On account of the cylindrical form of the material toto preparations were unsatisfactory for detailed study. Sections were cut 5 or 7μ thick and were stained with Ehrlich's acid haematoxylin, Delefield's haematoxylin or iron haematoxylin counterstained with erithrosin. Mallory's mixture also was found to give very satisfactory results.

PREVIOUS WORK ON RELATED FORMS

Before beginning the discussion of a new form, it may be of interest to note that only one Cyclophyllidean cestode, Taenia dispar Goeze (1782) has heretofore been described from an Anuran.

Taenia dispar was originally reported by Goeze from land toads and water toads in Germany. He describes it as being six inches long, cylindrical, of greatest diameter at the anterior end and diminishing gradually in size to a thread like posterior end. The name, dispar, was suggested by this unusual shape. The color is white except at the posterior end where it is brownish. Proglottids are distinct only near the posterior end in which region they are filled with numerous brown bodies. All of the proglottids are enclosed in a thin transparent membrane which is clearly visible between the proglottids at the posterior end. Observations were made upon living material placed in water and the great activity of the worm noted.

Goeze further states that this form has the usual four suckers, two larger and two smaller; and that the suckers open through small canals into the longitudinal canals which are now known to have an excretory function. Neither of these observations have been confirmed by subsequent workers.

Van Beneden (1853) reported Taenia dispar from Rana temporaria in Louvain. He made a careful study of the oncosphere and described its escape from the surrounding membranes, of which he saw two, and the peculiar movement of the hooks by which it is

enabled to penetrate the tissues of the host. He believed, however, that the oncosphere develops directly into a scolex by the acquisition of suckers and from this scolex the proglottids are reproduced asexually.

O. Schmidt (1855) studied some 80 or 90 specimens obtained from Rana temporaria. He gives a picture of a worm in which the neck is pronounced being about 1/2 the diameter of the scolex and 2/5 the diameter of the body where the testes are at their fullest development, some 18 mm. behind the scolex. Failing to find the female organs he apparently mistook the testes for ovaries,and while he gives us a description and figure of what is unmistakeably an oval cirrus pouch he fails to recognize it as such but considers it a part of the female system. He describes in detail the development of the embryo, not from a single cell, but from a group of cells, and the subsequent formation of capsules each surrounding three embryos, but makes the astonishing statement that no male elements enter into the formation of the embryo; that reproduction, in this form at least, is either parthenogenetic or asexual. Of the egg capsules he found 19 to 25 in each proglottid, first arranged in the form of a circle but later becoming scattered irregularly through the proglottid. He believed the infection to be transmitted through insects.

Fuhrmann (1895) summarizes the contributions of previous workers and adds a detailed and careful description of his own, a resume of which follows.

Taenia dispar is characterized by its cylindrical form and the fact that its diameter is greatest at the anterior end

and diminishes gradually toward the posterior end, from 0.6 mm. at the anterior end to 0.14 mm. at the posterior end. The total length of the worm is 140 mm. The length of the proglottids increases posterad to 2.7 mm. at the posterior end.

The scolex is unarmed and is not separated from the body by a neck. The pores are lateral and the cirrus and vagina pass dorsal to the longitudinal excretory vessels and the main nerve trunk.

The testes are two in number, measure 0.108 x 0.045 mm. and are situated in the dorsal part of the proglottid with their long axes directed transversely. The two vasa efferentia arise from the dorsal sides of the testes and unite at the median line to form a vas deferens which passes ventrad between the testes and very nearly to the ventral muscle bundles, then turns dorsad and enters the cirrus sac. The cirrus sac is a muscular organ having a diameter of 0.028 mm. and a length of 0.27 mm. It terminates in a retractor which extends to the muscle layer on the opposite side of the proglottid.

The female genital organs occupy the ventral part of the proglottid. The ovary is nearest the ventral surface. It is spherical, 0.081 mm. in diameter, is surrounded by a distinct delicate membrane and filled with 40 to 90 cells 0.014 mm. in diameter.

The vitelline gland lies dorso-lateral to the ovary, about in the median line, and on a level with the genital pore. It is spherical, 0.045 mm. in diameter, and filled with cells much smaller than the cells of the ovary.

The vagina opens from the genital pore near the cirrus

and is, at its beginning, surrounded by a pouch or sac closely resembling the cirrus sac but only 0.011 mm. in diameter. It follows the cirrus directly to the point where it meets the vitelline duct and oviduct just ventral to the end of the cirrus. No shell gland has yet been observed.

The mature eggs pass up the oviduct to the point where it meets the vitelline duct where the cavity is filled with yolk cells and sperm. No other ootype has been observed.

The uterus first appears as a mass of dark cells between the ovary and testes. At its fullest development it is a large horseshoe-shaped organ, the dorsal part of which crowds the remanents of the testes against the dorsal muscles. The uterus wall soon degenerates and the eggs receive their second and then their third membranes from the parenchyma. The parenchyma now becomes concentrated about groups of three or sometimes four eggs enclosing them in parenchymous capsules. These egg capsules, 13 to 30 in number, become scattered irregularly through the proglottid.

It is noteworthy that there are marked discrepancies between the figures and descriptions of Taenia dispar contributed by Goeze and Fuhrmann on the one hand and by O. Schmidt on the other hand. while the circular arrangement of the eggs described by Schmidt and the horseshoe-shaped arrangement described by Fuhrmann might readily be accounted for as differences in observation, there are more important differences which can not be so easily explained.

Whereas Goeze and Fuhrmann both picture and describe Taenia dispar as neckless and having its greatest diameter at the

anterior end and diminishing gradually toward the posterior end, Schmidt, as noticed above, gives a figure of a worm having a pronounced neck and its greatest diameter near the posterior end. And whereas Fuhrmann describes the cirrus sac as being almost ten times as long as broad, Schmidt gives us a picture of an oval cirrus sac not more than twice as long as broad.

These discrepancies would suggest the possibility that the form worked upon by Schmidt was not Taenia dispar, and that the number of Taenian species found in amphibians is greater than has heretofore been supposed.

Weinland (1858) attempted to put Taenia dispar in the genus Proteocephalus Weinland, a genus characterized by the extremely changeable form of the head which is without proboscis or hooklets and the presence of two shells surrounding the eggs, the outer one being mucilagenous. However the genus Proteocephalus is now believed to belong to an entirely different order from the genus in which Taenia dispar should be placed and, as shown above, the eggs of Taenia dispar have three membranes.

Diesing (1864) divided the genus Taenia, which then contained a large number of vastly different species, into two subgenes, Arynchotaenia and Rynchotaenia, separated by the absence or presence of a retractile apical organ or proboscis, and placed Taenia dispar in the former subgenus. Since then the old genus Taenia has been broken up into a great many genera,and Lühe (1899) proposed for Taenia dispar the generic name Nematotaenia,suggested by the cylindrical form and unsegmented appearance of the body.

Ransom (1900) gives the following diagnosis for the genus Nematotaenia:

"Paruterinae; Scolex unarmed without rostellum, Segmentation of strobila distinct only at the posterior end. Strobila circular in cross section. Genital pores alternate. Genital canals pass dorsal to the longitudinal excretory vessels and nerve. Uterus horse-shoe-shaped, disappears early. Eggs thru the action of numerous parauterine organs become inclosed in egg capsules, 3 or 4 in each capsule. Adults in Amphibia.

Type-species-Taenia dispar Goeze 1782."

Stiles and Hassall (1912) record the following as hosts of Taenia dispar: Bufo americanus, Menolranchus maculatus, Bufo vulgarus, Rana pipiens, Rana temporaria, Ascalabotes mauritanicus, Bufo cinereus, Bufo fuscus, Bufo lentiginosus, Hyla arborea, Necturus maculatus, Pleobates fuscus, Platydactylus guttatus, Rana halecina, Salamandra atra, Salamandra maculata.

MORPHOLOGY

External Characters

Specimens show great activity in tap water or a physiologic saline solution in which they live four to five hours. Young individuals 1.5 mm. long have been observed to crawl as far as 1 cm. on the bottom of a petri dish. During movement the suckers are successively expanded and directed forward though the locomotion is apparently accomplished by expanding and contracting the body. In large individuals no locomotion is accomplished because of the lack of coordination in the movements of the various regions of the body. Detached ripe proglottids,on the other hand, show considerable power of locomotion and have been known to travel as far as 3.5 cm. within four hours.

Adult worms bearing ripe proglottids vary in length from 25 to 40 mm. The most characteristic feature of the worm, noted upon a superficial examination, is its cylindrical form. The scolex is spherical, 127 to 180 μ in diameter in the region of the suckers which have a diameter about 2/5 of that of the scolex; thus in a scolex having a diameter of 160 μ the suckers would have a diameter of 64 μ. The neck is long and has an average diameter of 134 μ. The first appearance of the anlage of the reproductive system, in a worm 37 to 40 mm. in length, is as a dark streak down the center of the worm about 5 mm. behind the head. Here the diameter is still 134 μ.

Soon the line of undifferentiated cells becomes broken into triangles having their bases directed laterally and their

apices alternating with each other as they extend past the median line. About 6 mm. behind the head the differentiation of the testes becomes apparent. In this region the proglottids have a length of about 7μ and a diameter of 162μ . Eleven millimeters behind the head the proglottids are mature and the first eggs passing into the uterus. Here the proglottids measure 20μ by 157μ. The greatest diameter of the worm is found where the uterus has reached its fullest development and the para-uterine organ is forming, about 22 mm. behind the head. In this region the proglottids have a length of 40 to 45μ and diameter of 180 to 200μ. When the worm is in a contracted state the diameter in this region may be 250μ.

Soon after, about 24 mm. from the head, the proglottids begin to elongate rapidly and indications of external segmentation appear. They now have a length of 54μ and a diameter of 135μ. From 27 to 36 mm. behind the head the segmentation is very distinct. The proglottids measure 82 by 108μ and break off easily. The last few proglottids of a strobila and the detached proglottids frequently have a length much exceeding their diameter, 146μ by 72μ to 178μ by 74μ. Detached proglottids have been found singly and in groups of from two to five in the cloaca of the host.

In the living material the parenchymous para-uterine organs which contain the oncospheres appear as two transparent spherical bodies in the center of each proglottid.

Internal Anatomy

Body Wall

Cuticula. The cuticula is 3 to 4 μ thick and is composed of three layers the inner of which is the thickest. The outer layer is very thin and bears a great number of fine hair like spines which often reach a length of 3 to 3.5 μ. These spines are of such even length and so close together that they give a section the appearance of being ciliated. This outer spine bearing layer of cuticula is lost from the oldest ripe proglottids although it has been known to persist after external segmentation has become pronounced.

Beneath the cuticula is the usual basement membrane and parenchyma.

Musclature. Beneath the basement membrane a very delicate layer of circular muscles and a few scattered longitudinal muscle fibres can be distinguished. The principal musclature, however, consists of a single cylindrical layer of strongly developed longitudinally disposed strands of muscle fibres situated about two-thirds of the distance from the center of the worm to the periphery, and immediately beneath these longitudinal muscles a more delicate layer of circular muscles. The dorsi-ventral muscles appear to be entirely wanting.

Excretory System

The ventral excretory canals vary in diameter from 3.5 to 12 μ or usually from 5 to 7 μ in parts anterior to the appearance of external segmentation. The dorsal canals vary in diameter between 1 and 4.5 μ. They are but little smaller than the ventral

canals in the region of the scolex but are insignificant throughout the remainder of their length. The usual median excretory bladder is clearly visible at the posterior end of young specimens.

Reproductive System

All the organs of this system with the exception of parts of the cirrus and of the vagina are confined to the medullary region of the proglottid. The genital pores are lateral and alternate somewhat irregularly though with a marked tendency toward regularity. Thus in one instance twenty-four pores alternate regularly, then two are on the right and the next two at the left; then four alternate regularly, two are at the right, five alternate regularly and two more are at the right, twelve alternate regularly and two are at the left, etc. More than two pores have never been observed to occur successively on the same side. The cirrus and vagina pass dorsal to the main excretory canals and nerve trunk. The male organs occupy the dorsal part, the female organs the ventral part of the proglottid.

Male Organs. The single testis is situated dorsally on the aporal side of the proglottid. It varies from 24 to 34μ in diameter, half of those measured having a diameter of 29μ, and is spherical except when compressed antero-posteriorly by the contraction of the worm. From it the vas deferens leads with but few undulations directly to the cirrus.

The cirrus is surrounded by a thick club shaped cirrus pouch 34 to 37μ long and 13 to 14μ in diameter. The cirrus pouch, vas deferens, vagina, and other female organs are enclosed in a delicate sheath.

Female Organs. The vagina opens from the genital cloaca ventral to the male pore and follows the cirrus inward. Near the end of the cirrus sac the vagina turns sharply ventrad. An enlargement at the angle formed by this turning serves as a seminal receptacle. From the seminal receptacle the vagina continues ventrad as a spermatic duct to the fertilization space, where it meets the dorsally directed oviduct.

The single spherical ovary lies between the excretory canals near the ventral margin of the medullary region, somewhat poral to the median line. It has a diameter of 22 to 24 µ and consists of from 8 to 15 large, spherical, loosely arranged cells, 7 µ in diameter, surrounded by a membranous sheath. The contour of the ovary is less regular and its boundary less clearly defined than that of the testis so its spherical nature is less readily recognized.

The vitelline gland lies dorso-lateral to the ovary and in the median line. It is spherical, 18 µ in diameter, and composed of large, loosely arranged, deeply staining cells. The vitelline duct passes laterad meeting the oviduct in an enlargement at the point of formation of the uterine duct. No special muscular ootype and no shell gland have as yet been observed. A mass of deeply staining cells dorsal to the vitelline duct is the anlage of the uterus.

In early stages the seminal duct and vitelline duct meet the oviduct at two distinct points but as development proceeds the distal end of the oviduct becomes dilated including the openings of both of the other ducts in a common enlargement or ootype in which the ova are fertilized and receive the cells from

the vitelline glands before passing into the uterus.

Development

The ova, when mature, pass in rapid succession through the ootype and into the uterus so that the ovary and vitelline gland soon disappear entirely.

The Uterus, an oval sac, lies on the poral side of the proglottid with its long axis directed dorsi-ventrally. At its fullest development it attains a size of 40 x 24μ . The eggs, at the time they enter the uterus,may be surrounded by a transparent membrane though groups of ova and yolk cells around which no membrane has yet formed are frequently found in the uterus. The completed eggs have a mean diameter of 9.6μ .

The parenchyma on the aporal side of the uterus now becomes arranged as a meshwork of heavy, deeply staining strands running parallel to the long axis of the uterus and losing themselves in the surrounding parenchyma at either end. This is the beginning of the parenchymous structure which, following Fuhrmann, I shall term the para-uterine organ.

The growth of the para-uterine organ is rapid and it soon appears as two truncated cones, one dorsal and one ventral, their bases lying against the uterus which has become much flattened, and their apices extending almost to the circular muscles on the opposite side. The basal portion of the cones is composed of a meshwork of fine dorsi-ventrally directed fibres. The apical parts are surrounded by heavy deeply staining fibres among which lie numerous dark nuclei.

Meanwhile the eggs have initiated cleavage and have

developed their second membrane, a thick deeply staining capsule, while the uterus, which was pushed close against the eggs by the growth of the para-uterine organ, has broken down into a number of tertiary capsules surrounding the individual embryos.

With the rapid elongation of the proglottid the position of the cones is shifted so that their longitudinal axes correspond very nearly to the longitudinal axis of the worm. Their apices lie in the anterior end of the proglottid, and their basal portions, in which are the embryos enclosed in their uterine capsules, occupy the posterior part of the proglottid. At the same time the apical portions of the cones develop well defined walls and become somewhat constricted from the basal portions, while the spongy fibres which have filled them disappear leaving them hollow.

By the time the proglottids have become distinctly set off the apical portions of the cones appear as two thick walled hollow spheres about 20μ in diameter lying one dorsal,the other, ventral, in the anterior end of the proglottid, while the meshwork of lamellated fibres has largely disappeared from the interior of the basal portions of the cones. At this time the embryos have a mean diameter of 20μ, though they vary in diameter from 17 to 22μ, and have developed the six hooks characteristic of a tapeworm oncosphere.

The oncospheres now begin to migrate forward into the spherical capsules of the para-uterine organ which grow rapidly to a diameter of 125 to 135μ. At the time of the separation of the proglottids those embryos which have not yet migrated into the parauterine capsule are usually freed by the tearing open of the

end of the proglottid, so that a detached proglottid, when found in the cloaca of the host, frequently contains not more than five to seven oncospheres.

The development of the parauterine organ just described bears many resemblances to that described for Metroliasthes lucida by Ransom (1900). The chief differences are in the relative size and duration of the uterus and the number of para-uterine organs formed. In the form under discussion, as noted above, the uterus is relatively small and breaks down into membranes surrounding the embryos long before the development of the oncospheres is complete or the parauterine capsule is ready to receive them. In Metroliasthes lucida, quoting Ransom, "At the height of its development the uterus occupies almost the whole of the inner parenchyma back of the genital pore and bulges out the proglottis wall dorsally and ventrally," and the uterus does not degenerate until the six-hooked embryos have taken up their final position in the parauterine capsule.

As to the number of para-uterine organs formed, while in the form under discussion there are two, Metroliasthes lucida, although having a two lobed uterus, has but one.

Fuhrmann (1906) has given in less detail the development of the parauterine organ in Paruterina angustata and Culcitella rapacicola, (1908a) of Anonchotaenia globata, and (1909) of Biuterina clavulus. Cholodkovsky (1906) has given a brief account of the formation of the parauterine organ in Rhabdometra tomica. All of these forms resemble Metroliasthes lucida in that the uterus persists until the oncospheres have passed into the single parauterine organ.

On the other hand, Taenia dispar resembles this form in that the uterus breaks down early but far exceeds it in the number of parauterine organs, having from 13 to 30.

SYSTEMATIC POSITION

Braun (1900) gives a systematic classification of the Cestodes according to which the worm under discussion is placed in the Order Cyclophyllidea by the character and position of the reproductive glands, which are single and confined to the medullary portion of the proglottid.

Fuhrmann (1908b) has revised the classification of the Cyclophyllidea. Of his seven families it is the family Dilepinidae with whose characters this worm agrees. The family is defined as follows: "Selten ohne bewaffnetes Rostellum. Saugnäpfe unbewaffnet. Genitalpori randständig. Geschlechtsorgane in jeder Proglottis einfach oder doppelt. Uterus sehr verschieden gestaltet." This family contains 28 genera which Fuhrmann has separated into three sub families on the basis of the character of the uterus.

The sub family Dilepnae contains the genera in which the uterus is sac-shaped or has simple lobes: Dilepis, Trichocephaloides, Lateriporus, Choanotaenia, Anomotaenia, Fuhrmania, Leptotaenia, Amoebotaenia, Liga, Parvirostrum, Cyclustera, Laterotaenia, Proorchida, Angularia, Cyclorchida, Acanthocirrus and Chladotaenia. In most of these forms the uterus persists.

The sub family Dipylidiinae includes the genera in which the uterus breaks up into parenchymous capsules which contain one or more oncospheres; Dipylidium and Monophylidium.

The sub family Paruterinae includes those genera in which a parenchymous parauterine organ is formed into which the embryos later penetrate; Paruterina, Biuterina, Culcitella,

Rhabdometra, Metroliasthes, Anonchotaenia, and Nematotaenia.

The breaking up of the uterus into egg capsules described above would suggest that the worm under consideration in this paper might belong to the second sub family. However the enclosure of the embryos in a parauterine capsule suggests a relationship to the Paruterinae.

A comparison of the description of this form, given above, with the description of Taenia dispar given by Fuhrmann reveals striking resemblances between the two. Alike they are characterized by their cylindrical form and late differentiation of proglottids. The ovary and vitellaria are spherical and ventral, the vitellaria, however, being dorsal to the ovary. The testes are large, dorsal, and of a definite and limited number, 1 or 2. The cirrus and vagina are dorsal to the longitudinal excretory canals and the number of eggs produced in each proglottid is very small; 8 to 12 in the former, not more than 90 in the latter. They are alike in that the uterus breaks down early before the parauterine capsules have formed, and in having more than one parauterine organ.

Of the other six genera of the sub family Paruterinae five: viz., Paruterina, Biuterina, Culcitella, Rhabdometra, and Metroliasthes, are alike flattened dorsi-ventrally, the proglottids are distinct at the time of maturity or earlier, the female reproductive organs are anterior to the testes and the vitellaria posterior to the ovary. The testes are small, numerous (20 to 40) and of an inconstant number, and occupy the posterior part of the proglottid. The cirrus and vagina pass between the excretory canals (In Paruterina angustata, Fuhrmann, the dorsal canal has not been observed. The genital ducts, however, pass

dorsal to the ventral canal.) That the eggs are very numerous is suggested by the pictures though no one has ever counted them. The uterus is relatively large and persists until the embryos pass into the single parauterine organ.

Thus it is seen that the genera of Fuhrmann's sub family Paruterinae fall into two distinct groups in one of which is Nematotaenia; in the other the five genera named above.

The Genus Anonchotaenia differs somewhat from either group. While the testes are small and numerous, they are dorsally situated, and the ovary, vitellaria,and uterus are arranged laterally from the genital pore in the order named. However, this difference in the position of organs seems to be brought about by the shortness of the proglottid which would not permit the antero-posterior arrangement common in the other forms. Since,therefore, the Anonchotaenia are similar in general characters and in the aspect of the mature proglottid, and since the development of the parauterine organ and of the uterus, which persists until the embryos have passed into the parauterine organ, resembles that of Paruterina and Biuterina much more closely than that of any other form, I consider that Anonchotaenia is rightly placed in the sub family with Paruterina, Biuterina, Culcitella, Rhabdometra, and Metroliasthes.

For Nematotaenia and the species under consideration in this paper, because of the pronounced differences in the aspects of the mature proglottids, the early degeneration of the uteri and the late formation of the parauterine capsules, of which there are more than one in each proglottid, it seems necessary to establish a new sub family.

Sub Family Cylindrotaeniane

> Cylindrical Dilepinidae having one or two dorsally placed testes, ovary and vitellaria ventral, vitellaria dorsal to ovary. Proglottids only distinct at the posterior end. The Uterus breaks down early and the embryos are later enclosed in parauterine capsules.

On the other hand, notwithstanding their marked similarity in the respects noted above, Taenia dispar and this new worm show certain important differences.

As to external characters it may be mentioned that whereas the former has its greatest diameter at the anterior end and dminishes gradually to the posterior end, the latter has its greatest diameter about midway of the strobila and narrows toward both ends.

Of greater importance is the difference in the male reproductive system. Whereas Taenia dispar has two symmetrically placed oval testes and the vas deferens forms a loop which passes ventrad as far as the excretory canals, this new worm has a single spherical testis situated lateral to the median line of the proglottid and a simple almost straight vas deferens. And whereas the cirrus sac of Taenia dispar is almost ten times as long as wide, that of the worm herein discussed is only 2 1/2 times as long as wide.

In the female system, too, the differences are pronounced for in Taenia dispar the vitelline gland lies on a level with the genital pore and the vitelline duct meets the oviduct at a point just ventral to the end of the cirrus sac,while in this new worm the vitelline gland lies very close to the ovary and has a short duct meeting the oviduct much nearer the median line and but little dorsal to the excretory canals.

Nowhere are the differences more striking than in the development of the parauterine organs and the aspect of the mature proglottids, for in place of the two large and elaborate cone-shaped structures noted above Taenia dispar has a varying number of insignificant aggregations of parenchyma scarcely recognizable as the same structure; and in place of the two large, transparent, spherical parauterine capsules found in the ripe proglottids of this form, the ripe proglottids of Taenia dispar have from 13 to 30 small dark capsules scattered through the parenchyma.

From these considerations it becomes quite evident that this form does not belong to the genus Nematotaenia which it most closely resembles of any of the genera yet established, but that it is necessary to establish a new genus for its reception.

Its generic description would be as follows:

Genus Cylindrotaenia

Scolex unarmed, without rostellum; reproductive organs single in each proglottid; pores lateral, alternating: vagina and cirrus dorsal to the excretory canals and main nerve; testis one, dorsal; ovary and vitellaria ventral; uterus breaks up into capsules surrounding the embryos which ultimately pass into two parauterine capsules.

Type-Species-Cylindrotaenia acris

Characters given above.

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EXPLANATION OF PLATE

C. P.	Cirrus pouch.	R.	Retractor.
E.	Egg.	R. S.	Seminal receptacle.
E. C.	Excretory canals.	Sh.	Sheath.
Em.	Embryo.	T.	Testis.
G. C.	Genital cloaca.	U.	Uterus.
L. M.	Longitudinal muscles.	U. C.	Uterine capsules.
N.	Longitudinal nerve.	V.	Vagina.
O.	Ovary.	Vd.	Vasdeferens.
P. U.	Parauterine organ.	Vit.	Vitellaria.
P. U. a.	Apical portion of parauterine organ.	Vit. d.	Vitelline duct.
P. U. b.	Basal portion of parauterine organ.		

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Fig. 1. Cross section of scolex. X 420.

Fig. 2. Cross section of a mature proglottid. X 420.

Fig. 3. Frontal section of three proglottids anterior to the above. X 360.

Fig. 4. Cross section through a proglottid with fully developed uterus, and the parauterine organ forming. X 410.

Fig. 5. Cross section of a proglottid in the region of greatest diameter. X 340.

Fig. 6. Sagittal section of a proglottid at the beginning of external segmentation. X 480.

Fig. 7. Cross section of the same. X 480.

Fig. 8. Sagittal section of a proglottid from near the end of the strobila. Embryos migrating into the anterior portions of the cones. X 420.

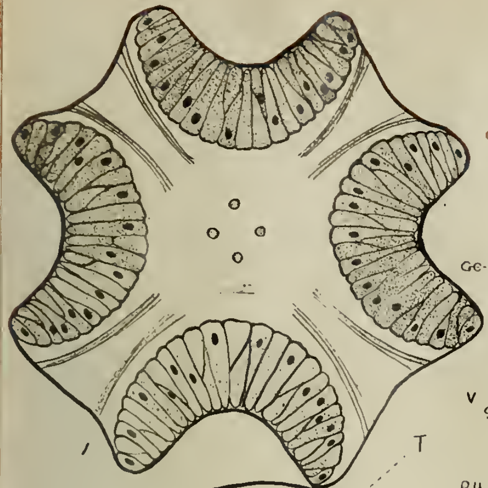
Fig. 9. Detached ripe proglottid. Toto preparation. X 480.

Fig. 10. Scolex of a young individual. Toto preparation. X 50.

Fig. 11. Section of cuticula. X 500.

Fig. 12. Proglottid of Paruterina angustata. After Fuhrmann (1906).

Fig. 13. Cross section of a mature proglottid of Taenia dispar. After Fuhrmann (1895).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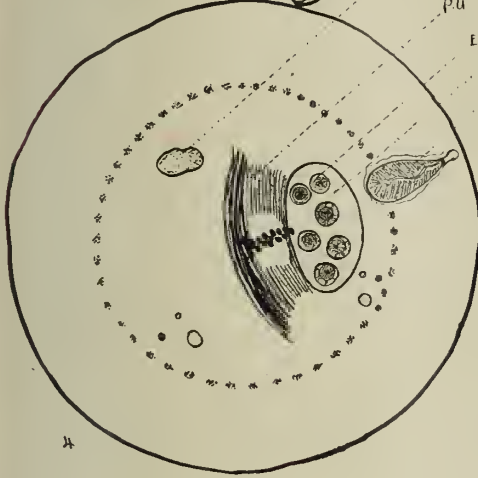

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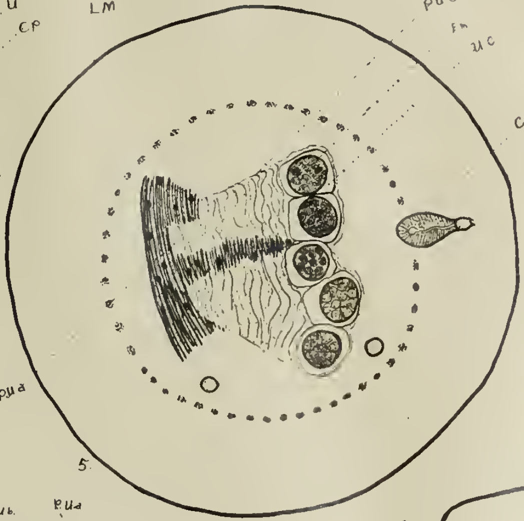

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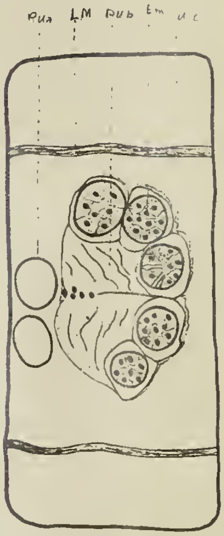

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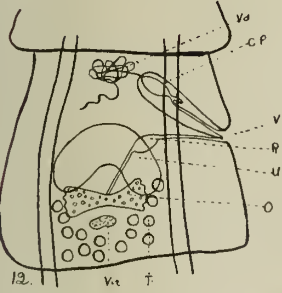

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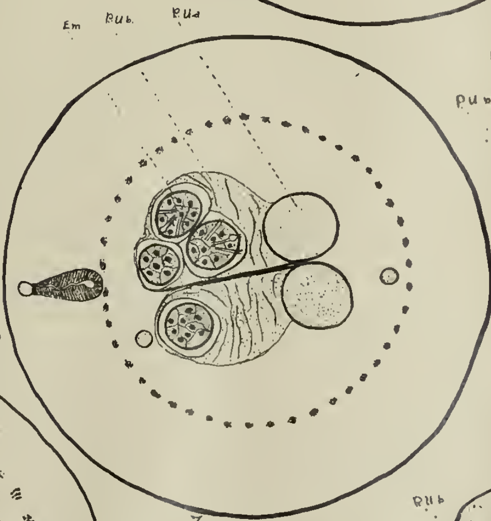

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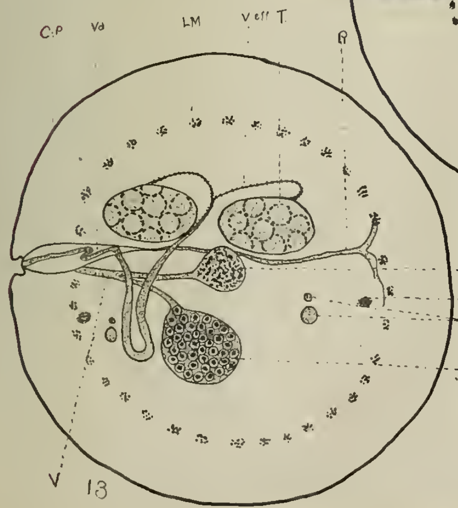

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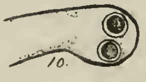
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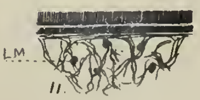

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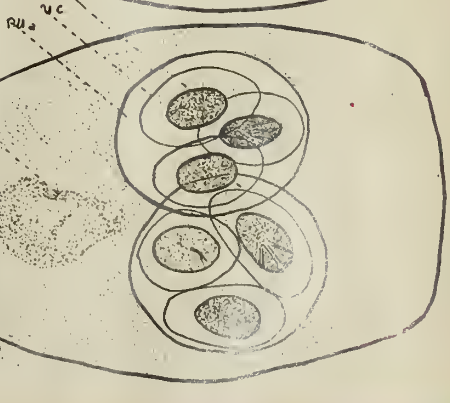

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